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Data mining for autonomous wearable sensors used for elderly healthcare monitoring

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Abstract

The paper presents some aspects regarding data mining used modeling and prediction of the patients' health state parameters.

The proposed wearable device integrated by using wireless personal networks (WPNs) can sense, process and communicate vital signs through internet for healthcare monitoring. These WPNs are fitted for medical applications and offer continuous ambulatory health monitoring by using non-invasive methods. Generally, the body sensor network (BSN) for medical applications are based on big data fusion and cloud computing technologies (PaaS, SaaS - for data storage and sharing solutions).

The big data fusion includes preprocessing (filter the noise), feature extraction (data abstraction), data fusion computation (modeling different information type and fusion), and data compression (reducing the information stored in memory and transmitted by the transceiver).

The fusion between wearable wireless body sensor network (WWBSN), IoT and Cloud Computing will allow doctors, emergency stations or caregivers to track and receive data from BSNs about patients in different places. By using biomedical sensors can be studied the human behavior and physiology, the body's response physiologically and emotionally to various physical and mental diseases. The WWBSN can cover monitoring for cardiovascular, diabetic problems or mental disorders (Alzheimer).

***Keywords**: data mining, elderly healthcare, sensors*

Motivation

The motivation source for doctoral thesis study was the case of elderly patients monitoring (fig. 1). The elderly patients are dealing with comorbidity phenomena characterized by association of diseases like cardiovascular problems (hypertension, hypotension), cardiovascular problems (hypertension, hypotension), nonphysical activities (obesity) and Alzheimer. Comorbidity is associated with worse health outcomes, complex clinical management and increased health care costs.

The monitoring of the elderly patients in their living environment by using wireless sensors network (optical sensors, gyroscopes and accelerometers) presents a high interest for scientists in order for failure detection [1].

For diabetic elderly and for person with cardiovascular diseases the posture of the body and rapidity on changing the body posture coordinates can indicate critical situations like failure, tremors or heart attack.

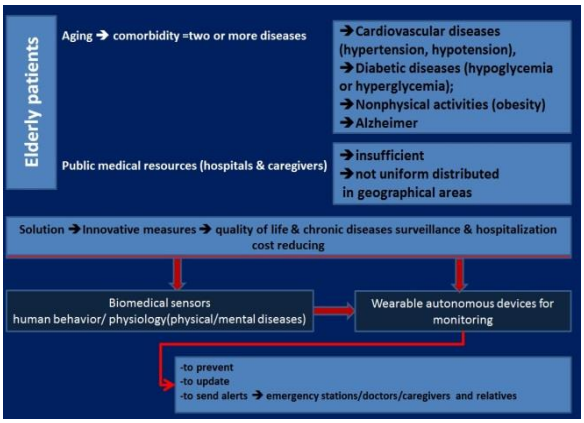

Fig. 1 Wearable monitoring system-motivation

Thesis idea

The doctoral thesis "Theoretical and experimental contributions to the monitoring of vital parameters using intelligent control systems based on sensors integrated into textile structures and Cloud Computing services" idea is to track vital parameters data from wearable sensors integrated in textile structures.
The purpose of this thesis is to create a wearable monitoring system for elderly patients.
The textile technology allow the weaving, sewing and knitting of conductive yarns into the flexible structures, but in case of integration of the electronic components (sensors, actuators and computational devices) on the textile surface (e-textile), may occurs constraints related to system design which require high computational performance, low power consumption and fault tolerance.
The nature of the textile (discrete model) and the faults which occur due to the open and short circuits can disconnect/drain the battery and can affect both battery life and the performance of the textile with conductive yarns, which finally affect the accuracy signals from the textile structure made with conductive yarns [2].
Usage of the semiconductors in textiles structures for the connections sensors/actuators – motherboard affect signals data accuracy because of the yarns resistivity modifications with temperature and skin humidity variations, body thermal flow and due to the textile property to be good thermal conductor [2].
Big data in medical, physical sciences and financial area generate a huge volume of data collected, which required new technologies and complex algorithms and software for collecting, storage and managing the big data.
For big data from biomedical sensors analysis, data mining methods allow predictive modeling of data in order to obtain the disease risk assessment and disease model in correlation with patient behavior.

Conclusion

By defining fault like a physical defect or imperfection that occurs in some hardware (sensors, actuators) or software component (a short circuit between two adjacent interconnects, a broken pin, or a software bug) and knowing the cause-effect model for fault-error-failure (faults cause errors and errors causes for failures effects) can conclude that usage of conductive textile yarns for data transmission can cause system monitoring failure and false data.
Wearable sensors system for health monitoring should allow [2]:
-fault tolerance control implementation;
-big data fusion for extract the values and establish optimal decisions based on predictive modeling;
-sensor data processing algorithm for reducing the noise and data discretization;
Wearable electronics integrated in textile structure experience a data losses and low accuracy signals due to the textile structure properties. In design of textile structures with electronics integrated must consider the noise that could occur due to the conductive yarns length and resistivity in correlation with temperature and skin humidity.
In case of diabetic patient study case the critical values for biomedical signal (pulse, temperature, humidity and breath rhythm) are sent to fault tolerance control unit and after comparison is selected the optimal decision and are sent the message alerts.

In case of diabetic elderly patient for establish the critical situation we analyze the correlation between breath rhythm, humidity, pulse and temperature values obtained from wearable sensors:

Hypoglycemia=f (temperature, pulse, breath rhythm, pulse)

Hyperglycemia=f (temperature, pulse, breath rhythm, pulse)

In many cases the sensors output may generate the errors which can be considered like fault events [2]:

-partial or total output loss;

-abrupt/continuous switching between modes of functioning;

- Nonlinear aberrations;

Future work

For developing the monitoring system will be required to analyze, collect and storage the big data.

For analyzing the parameters from patients will be developed a support decision system (fig. 2). The system architecture will consist in 5 levels:

➔Level 1 - data transmission (biomedical sensors aggregators);

➔Level 2 - big data (data collecting, discretization and storage);

➔Level 3 - medical information (data mining)

➔Level 4 - diseases knowledge (data synthesis)

➔Level 5 - decision support system

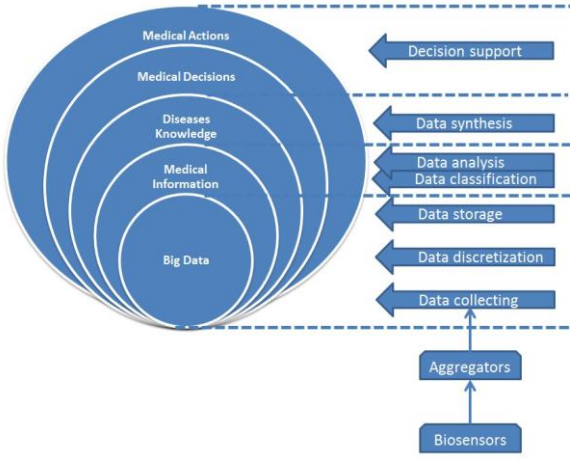

Fig. 2 Decision system architecture- big data monitoring [3]

The software will be available in two versions – for smartphone (fig. 3) and pc and will offer:

➔Usability
➔Autonomy
➔Portability

Fig. 3 Patient data management software-mobile app

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